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Oku

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[54] **SYSTEM FOR CONTROLLING SEMICONDUCTOR**

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[73] Assignee: **Machida Endoscope Co., Ltd.**, Tokyo, Japan

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[51] **Int. Cl.**[6] **H01H 7/16**

[52] **U.S. Cl.** **307/119**; 307/112; 307/113; 439/489; 327/475; 327/545; 606/109; 606/117

[58] **Field of Search** 307/119, 113, 307/112; 439/489; 128/6, 4; 327/545, 475

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Primary Examiner—William M. Shoop, Jr.
Attorney, Agent, or Firm—Fish & Richardson P.C.

[57] **ABSTRACT**

A device that provides a control system which is capable of positively preventing a semiconductor from suffering from latch up. In order to prevent this latch up, a control circuit controls the semiconductor through a power source switch. The control circuit is capable of supplying a constant voltage to a power source terminal of the semiconductor when it is electrically connected to the power source circuit by turning on the power source switch, and thereafter supplying a control signal to a control terminal of the semiconductor. The control circuit is capable of stopping the output of the control signal to the control terminal and then stopping the supply of voltage to the power source terminal when disconnected from the power source circuit by turning off the power source.

3 Claims, 3 Drawing Sheets

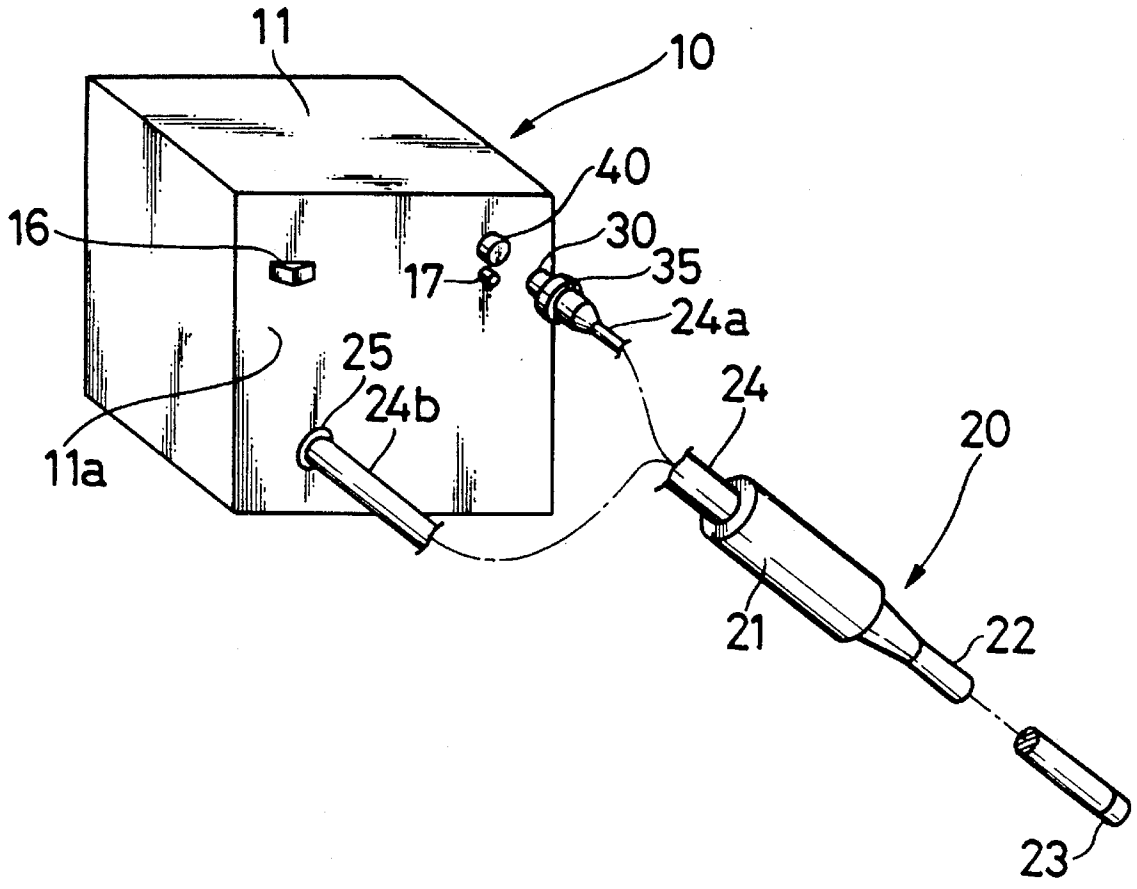


Fig. 1

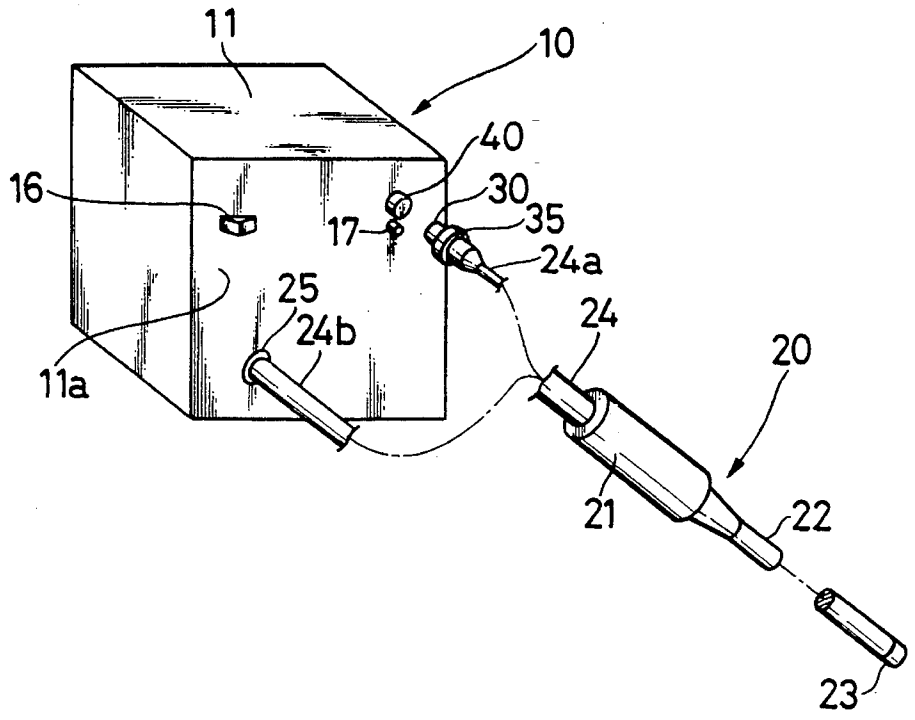

11
10
40
16
30
35
17
24a
25
24b
24
20
11a
21
22
23

Fig. 2

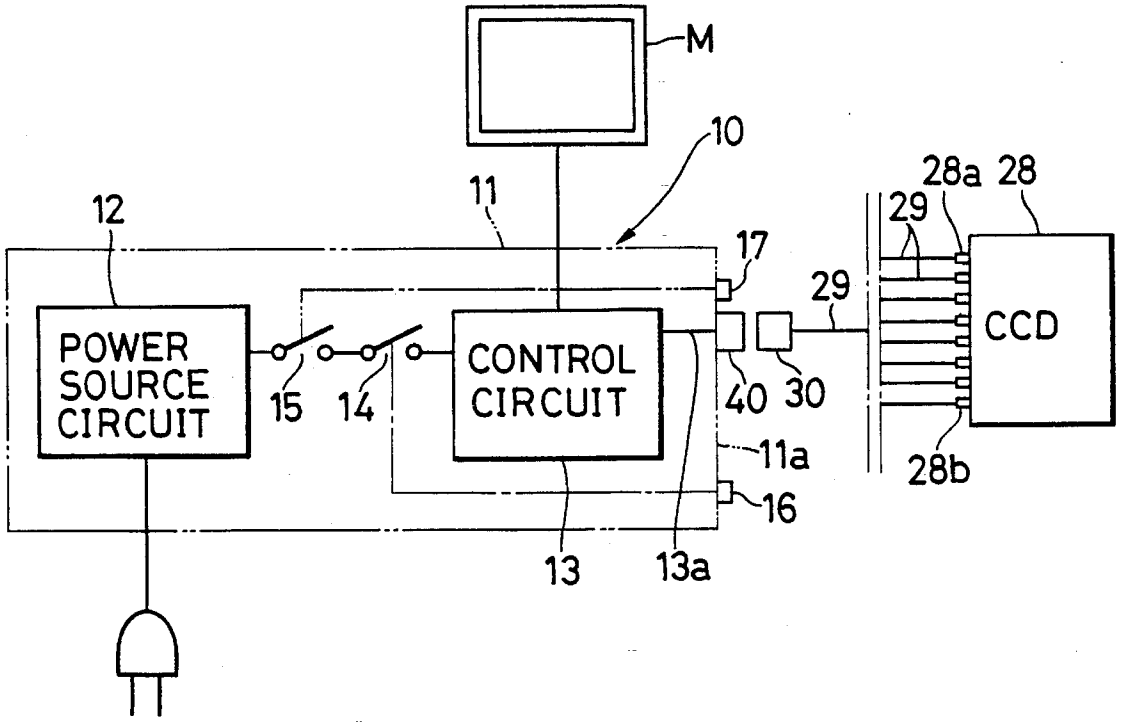

M
10
11
12
28a
28
29
17
29
POWER SOURCE CIRCUIT
15
14
CONTROL CIRCUIT
CCD
40
30
11a
16
28b
13
13a

Fig.3A

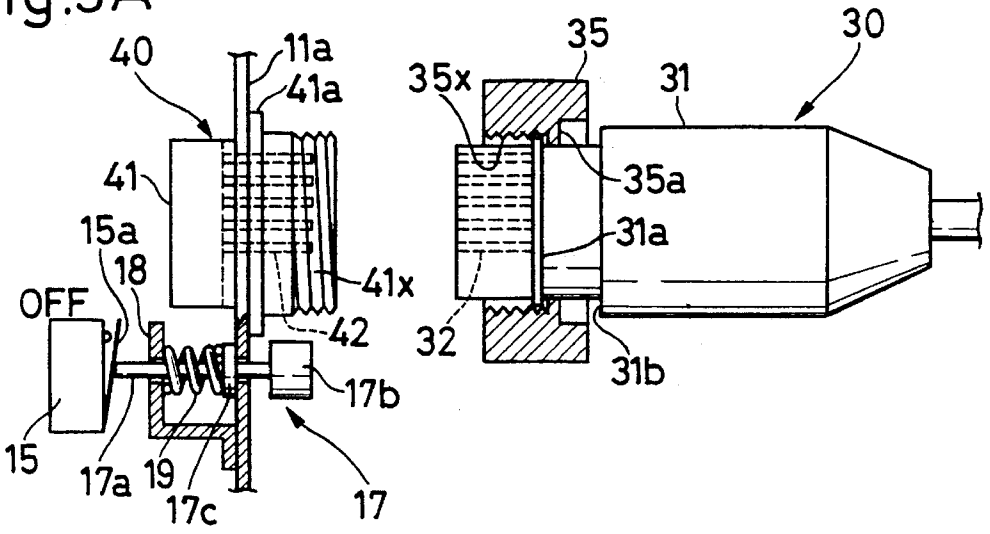


Fig.3B

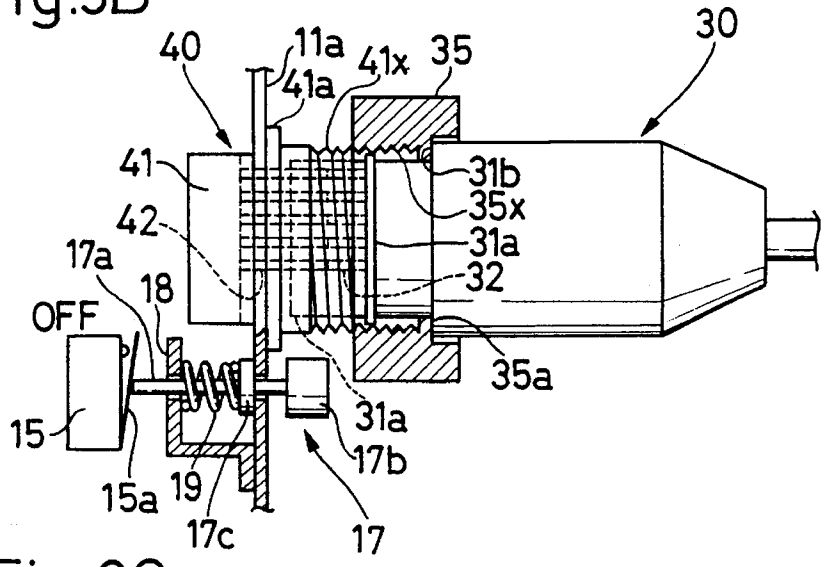


Fig.3C

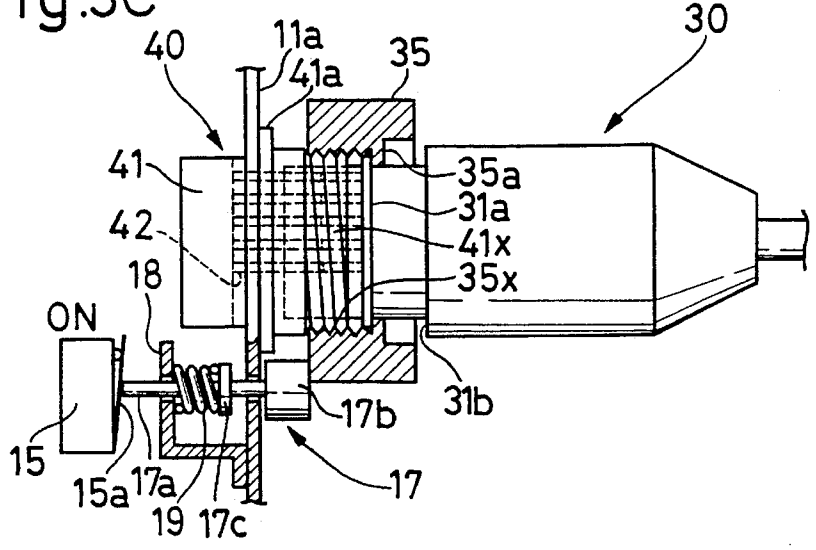


Fig. 4

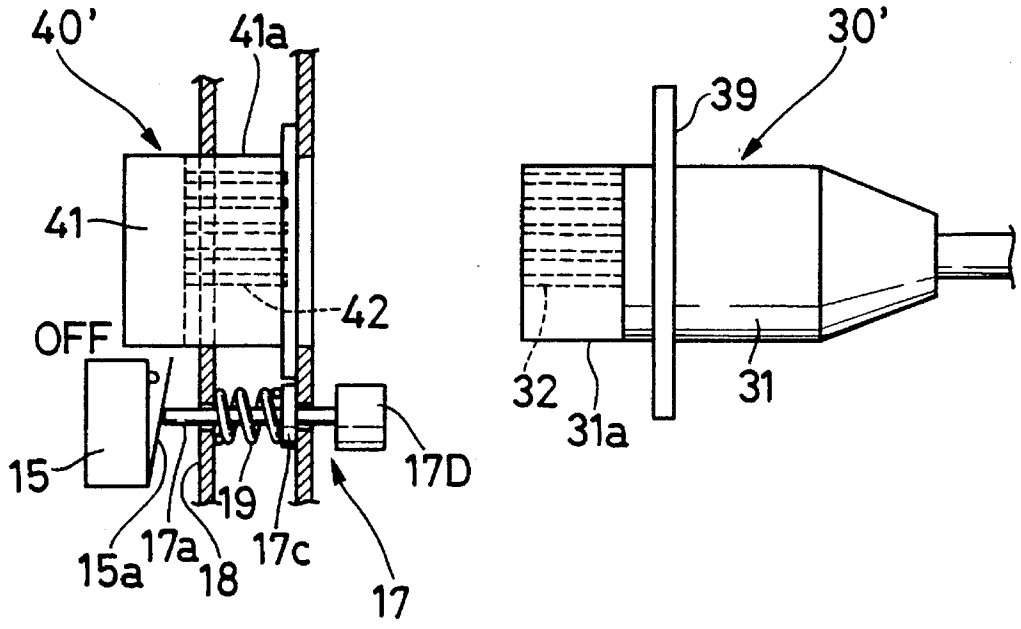
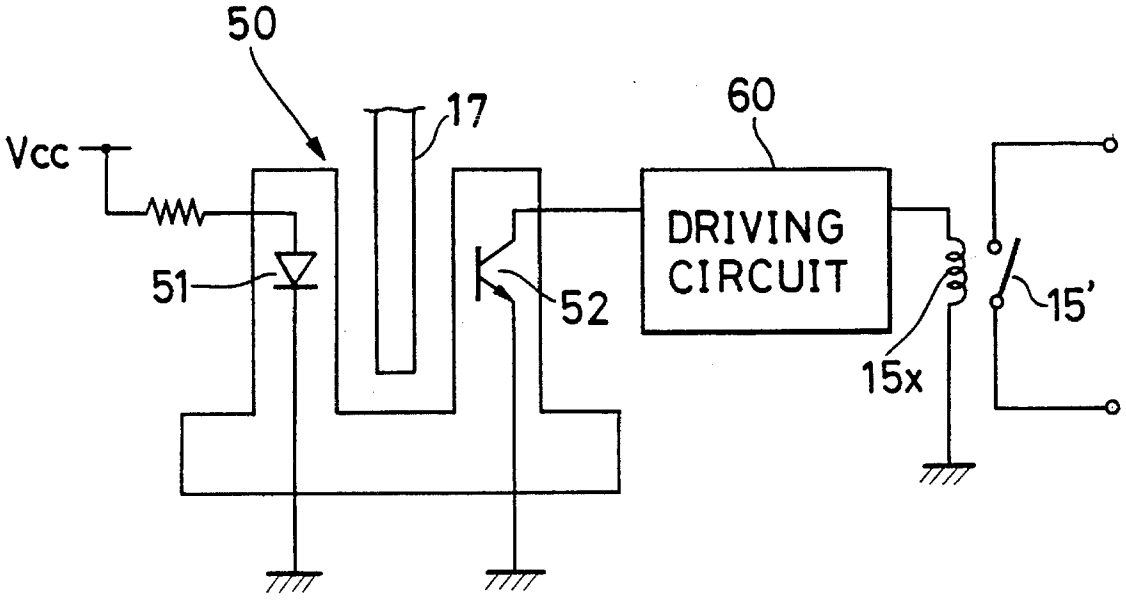

40'
41a
41
42
OFF
15
15a
17a
18
19
17c
17
17D
30'
39
32
31a
31

Fig. 5


50
17
60
Vcc
51
52
DRIVING CIRCUIT
15'
15x

SYSTEM FOR CONTROLLING SEMICONDUCTOR

BACKGROUND OF THE INVENTION

This invention relates to a system for controlling a semiconductor such as a CCD, and more particularly to an improvement of a construction for connecting an instrument having a semiconductor and a control unit to each other.

Taking, for example, an electronic endoscope system as disclosed in Japanese Laid-Open Patent Application No. Sho 59-70382, this system comprises an endoscope, a control unit connected to this endoscope, and a monitor television connected to this control unit. In operation, this endoscope is inserted into a patient's body and his/her body cavity is observed while watching the monitor television.

The endoscope includes a body, an insert portion extending from the body, a CCD (semiconductor) acting as an image pick-up element, which is mounted on a distal end of the insert portion, and a cable extending backwardly from the body. A first connector is mounted on a distal end of the cable. This first connector is connected to the CCD through electric wires passing through the cable, the body and the insertion portion.

The control unit contains therein a power source circuit for converting an AC voltage to a DC voltage, a control circuit which receives the DC voltage from the power source circuit, and a power source switch interposed between the power source circuit and the control circuit. The operating portion of the power source switch is mounted on a front wall of a housing of the control unit. A second connector is mounted on the front wall of the housing and connected to the control circuit.

The first connector of the endoscope is removably connected to the second connector of the control unit. By this, the control circuit and the CCD are connected to each other.

Incidentally, the CCD, like other semiconductors, has a possibility of suffering from a latch-up phenomenon. This latch-up occurs when a signal terminal is received in the state where no voltage is supplied to a power source terminal of the semiconductor. This results in breakage of the CCD.

In order to prevent this latch-up, the above-mentioned control circuit controls the semiconductor in the following manner. When the power source switch is turned on and the control circuit is connected to the power source circuit, the control circuit outputs a control signal to the signal terminal after it supplies the voltage to the power source terminal of the semiconductor. On the other hand, when the control circuit is disconnected from the power source circuit by turning off the power source switch, the supply of voltage to the power source terminal is stopped after the output of the control signal to the signal terminal has been stopped.

In the case where the first and second connectors are connected to each other in the OFF-state of the power source switch, and thereafter, the power source switch is turned on, the control circuit exhibits a latch-up preventive function. Therefore, a possible breakage of the CCD can be positively prevented. Also, in the case where the power source switch is turned off first and then the connecting state between the first and second connectors is removed, the control circuit exhibits the latch-up preventive function. Therefore, breakage of the CCD can be positively prevented.

However, in the case where the first and second connectors are connected to each other after the power source switch is turned on, the latch preventive function by the control circuit does not work any more. In addition, since the contact elements of the first and second connectors for transmitting control signals are often contacted immediately before the contact elements for supplying voltage to the power source terminal of the CCD are contacted to each other at the starting time of the connecting operation, the CCD receives the control signal before it receives the supply of voltage to the power source terminal. As a result, the CCD is broken by latch-up. Similarly, in the case where the connection between the first and second connectors is removed in the state where the power source switch is in the ON-state, there is still a possibility that the CCD is broken by latch-up.

In order to prevent the latch-up, it was a conventional practice to request the user to turn on the power source switch after the connector devices are connected and then remove the connection between the first connector and the second connector after the power source switch is turned off.

However, since this on/off operation of the power source switch and the sequential order of connection of the connectors are left to the user's manual operation, the CCD is frequently subjected to a failure by the user who inadvertently connects the connectors in wrong order.

SUMMARY OF THE INVENTION

The present system controls a semiconductor which comprises a first connector mounted on a cable, a second connector mounted on a front wall of a housing, a power source switch and a preventing means for preventing latch up from occurring in the system controlling the semiconductor.

One way latch up can be prevented is by having a connection ring mounted on an outer periphery of the first connector. After the contact elements of the first and second connector are connected to each other, the connection ring is threadedly engaged with the second connector. Once engaged the connection ring presses the operating portion for the power source switch to turn on the power source switch. By having the power source switch turned on after contact elements of the connectors are connected latch up is prevented.

Another way latch up is prevented is to have a flange formed on the outer periphery of the first connector.

The other features and advantages of the present invention will become apparent from the following explanation.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a perspective view showing a general construction of an electronic endoscope system according to the present invention;

FIG. **2** is a circuit diagram of the electronic endoscope system;

FIGS. **3**(A) to **3**(C) are sectional views sequentially showing various states of connectors and a power source switch which are used in the above system, in the order of the connecting processes;

FIG. **4** is a sectional view showing connectors and a power source switch according to a modified embodiment; and

FIG. **5** is a circuit diagram of a power source switch according to a modified embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

One embodiment of a semiconductor control system according to the present invention, which is mounted on an

electronic endoscope system, will be described with reference to FIGS. 1 to 3. As shown in FIGS. 1 and 2, the electronic endoscope system comprises a control unit **10**, a monitor television M connected to the control unit **10**, and an endoscope **20** removably connected to the control unit **10**.

As shown in FIG. 1, the endoscope **20** includes a body **21**, a flexible insert portion **22** extending from a distal end of the body **21**, a tip **23** disposed on a distal end of the insert portion **22**, a common cable **24** extending from a rear end of the body **21**, and two branch cables **24***a* and **24***b* branched from the common cable **24**. A distal end portion of the insert portion **22** can be bent by means of remote control using a control member (not shown) mounted on the body **21**. A plug **30** (first connector) is mounted on a distal end of the branch cable **24***a*. An optical connector **25** is mounted also on the distal end of the other branch cable **24***b*.

The tip **23** is provided at distal end face thereof with an observation window and an illumination window. The illumination window and the optical connector **25** are optically connected to each other by a bundle of optical fibers (not shown). This bundle of optical fibers are allowed to pass through the insert portion **22**, the body **21**, the common cable **24**, and the branch cable **24***b*. A light source device (not shown) is received in the housing **11** of the control unit **10**. An illumination light from the light source device is irradiated through the illumination window after passing through the optical connector **25** and the optical fibers.

On the tip **23**, there is provided a CCD **28** (semiconductor, see FIG. **2**) acting as an image pick-up element, which is placed opposite to the observation window through an objective lens system. A power source terminal **28***a* and signal terminals **28***b* of this CCD **28**, and a plurality of female-type contact elements, as later described, of the plug **30** are connected together by a plurality of signal lines **29** (several signal lines are grouped and indicated by a single line in FIG. **2**). These signal lines **29** are allowed to pass through the insert portion **22**, the body **21**, the common cable **24** and the branch cable **24***a*.

The above plug **30** is conventionally known and has, as shown in FIG. **3**A, a cylindrical body **31** and the plurality of female-type contact elements **32** supported by the body **31**. The female contact elements **32** are received in a distal end portion of the body **31** and allowed to extend in parallel to the axis of the body **31**, with its distal end facing an open end of the body **31**.

A connection ring **35** (pressing member) is mounted on the plug **30** such that the ring can move in the axial direction and turn about the plug **30**. An engagement flange **35***a* is formed on an intermediate portion of an inner periphery of the connection ring **35**. The movable range of the connection ring **35** in the axial direction is determined by a front engagement position where the engagement flange **35***a* contacts an engagement flange **31***a* formed on the outer periphery of the body **31** and a rear engagement position where an engagement flange **35***a* contacts an annular step **31***b* formed on the outer periphery of the body **31**.

A female-thread **35***x* is formed in the inner periphery of the connection ring **35** but at a location shifted forwardly from the engagement flange **35***a*.

The control unit **10** includes, within a housing **11**, a power source circuit **12** for converting an AC voltage to a DC voltage, and a control circuit **13**.

Two power source switches **14** and **15**, which are mutually arranged in a serial relation, are interposed between the power source circuit **12** and the control circuit **13**.

Operating portions **16** and **17** of the power source switches **14** and **15** and a receptacle **40** (second connector), which is connected to the control circuit **13** through a plurality of electric wires **13***a* (a single wire as a group of several wires is shown in FIG. **2**), are mounted on the front wall **11***a* of the housing **11**.

The receptacle **40** is known. As shown in FIG. **3**A, the receptacle **40** comprises a cylindrical body **41**, a plurality of pin-like male-type contact elements **42** supported within the body **41**. Each contact element **42** is allowed to extend in parallel with the axis of the body **41** and surrounded by the body **41**, with its distal end facing the open end of the body **41**. The body **41** is allowed to extend through the front wall **11***a* such that its axis extends perpendicular to the front wall **11***a* of the housing **11**. A flange **41***a* is formed on the outer periphery of the body **41**. By fixing this flange **41***a* to the front wall **11***a*, the body **41** is fixed to the front wall **11***a*. A male-thread **41***x* is formed on the outer periphery of the distal end of the body **41**. The previously mentioned female-thread **35***x* of the connection ring **35** is threadedly engaged with the male-thread **41***x* of this receptacle **40**.

As shown in FIG. **2**, the operating portion **16** of the power source switch **14** is of a see-saw type and mounted on the front wall **11***a* of the housing **11** but situated away from the receptacle **40** as in the case with the conventional device. As shown in FIGS. **1** to **3**, the operating portion **17** of the other power source switch **15** protects from the front wall **11***a* in the vicinity of the receptacle **40**. In this embodiment, although the operating portion **17** is arranged below the receptacle **40**, FIG. **2** does not show a correct positional arrangement. It should be noted that this operating portion **17** may of course be situated above, right or left of the receptacle **40**.

As shown in FIG. **3**A, the operating portion **17** of the power source switch **15** includes a shaft **17***a*, a button portion **17***b* disposed at an external end of the shaft **17***a*, and a spring retainer portion **17***c* disposed at an intermediate portion of the shaft **17***a*. The shaft **17***a* is allowed to extend through the front wall **11***a*, and a bracket **18** secured to the front wall **11***a*. Between this bracket **18** and the spring retainer portion **17***c*, a compressed coil spring **19** is interposed such that the spring **19** is wound on the shaft **17***a*. The shaft **17** is biased outwardly by the resiliency of the coil spring **19** and the spring retainer portion **17***c* is in contact with the front wall **11***a*. In that state, the button portion **17***b* is away from the front wall **11***a* and located forwardly of the front wall **11***a*. Although an inner end of the shaft **17***a* is in contact with a contact element **15***a* of the power source switch **15** having the form of a micro-switch, the power source switch **15** is in the OFF-state.

With the above construction, the CCD **28** of the endoscope **20** is connected to the control circuit **13** within the control unit **10** by inserting the plug **30** into the receptacle **40**. More specifically, as shown in FIG. **3**A, the operator holds the plug **30** such that the plug **30** coaxially faces the receptacle **40**. Then, by moving the plug **30** toward the receptacle **40**, the body **31** of the plug **30** is inserted into the body **41** of the receptacle **40**. Further movement of the plug **30** in the mentioned direction causes the contact elements **32** of the plug **30** to mutually fit for electric connection to the contact elements **42** of the receptacle **40** as shown in FIG. **3**B.

When the plug **30** is inserted, the distal end of the female-thread **35***x* of the connection ring **35** contacts the distal end of the male-thread **41***x* of the receptacle **40** and therefore, the connection ring **35** is prevented from further movement. As a result, the ring **35** is retreated relative to the plug **30**. The plug **30** is stopped by the step **31***b* being

contacted with the engagement flange **35***a* of the connection ring **35**. When the plug **30** is in its stop position, the contact elements **32** of the plug **30** are all positively connected to all contact elements **42** of the receptacle **40** over a predetermined length. It should be noted that the plug **30** may be stopped by other suitable means. For example, it may be designed such that before the step **31***b* contacts the flange **35***a*, the distal end of the body **31** of the plug **30** contacts a stopper formed inside the receptacle **40**.

In FIG. **3**B, special attention should be paid to the fact that when the distal end of the connection ring **35** is in contact with the distal end of the receptacle **40**, the connection ring **35** is away from the button portion **17***b* of the operating portion **17** of the power source switch **15** and therefore, the power source switch **15** is maintained in the OFF-state. Accordingly, in this OFF-state of the power source switch **15**, the contact elements **32** of the plug **30** and the contact elements **42** of the receptacle **40** are fully connected to each other.

Next, as shown in FIG. **3**C, the connection ring **35** is turned so that the female-thread **35***x* is threadedly engaged with the male-thread **41***x* of the receptacle **40**. By doing this, the plug **30** and the receptacle **40** are firmly connected together (i.e., connection is completed).

When the connection ring **35** is brought into engagement with the receptacle **40**, the connection ring **35** is moved in the axial direction and pushes the button portion **17***b* of the operating portion **17** of the power source switch **15** with its distal end face. Therefore, the shaft **17***a* of the operating portion **17** is retreated to push the contact element **15***a* of the power source switch **15** with its inner end, so that the power source switch **15** is turned on. This turning-on operation of the power source switch **15** is performed before the completion of the threaded-engagement by the connection ring **35**.

Next, the operating portion **16** of the power source switch **14** is operated to turn on the power source switch **14**. As a result, the DC voltage from the power source circuit **12** is supplied to the control circuit **13**. In response to this, the control circuit **13** starts controlling the CCD **28**. In the control circuit **13**, a constant voltage is supplied to the power source terminal **28***a* of the CCD **28** first and then, a control signal is output to the signal terminals **28***b*. What is important here is that at the time when the control circuit **13** starts its controlling operation, connection between the connectors **30** and **40** are completed, and the control circuit **13** and the CCD **38** are already electrically connected to each other. As a result, the supply of constant voltage and the output of control signal are performed in given order by the control circuit **13** and therefore, latch-up can be positively prevented and thus, breakage of the CCD **28** can be prevented.

Next, for removing the endoscope **20** from the control unit **10**, the connection ring **35** is likewise turned but in the reverse way so as to be retreated. As this connection ring **35** is retreated, the operating portion **17** is projected by the force of the coil spring **19** and the power source switch **15** is turned off. By this, the control circuit **13** finishes its controlling operation with respect to the CCD **28**. At the time of finish of the controlling operation, since the control circuit **13** stops supplying the constant voltage to the power source terminals **28***a* of the CCD **28** after the output of the control signal to the CCD **28** is stopped, latch-up of the CCD **28** can be prevented. At that time, since the connection between the plug **30** and the receptacle **40** is maintained, the latch-up preventing operation is assuredly performed. By further loosening the engagement of the connection ring **35** so as to further retreat the connection ring **35** after the power source switch **15** is turned off, the connection ring **35** is removed from the receptacle **40**. Then, the plug **30** is pulled out of the receptacle **40** to remove the connection between the contact elements **32** and **42**. At the time of the removal of connection, since the controlling operation with respect to the CCD **28** is already finished, the removal of connection does not affect adversely to the CCD **28**.

The user is requested to turn off the other power source switch **14** before removing the connection between the plug **30** and the receptacle **40**. Even if the user should forget this turning-off operation, the latch-up prevention is ensured because the power source switch **15** is already in the Off-position when the connection is to be removed.

In the above embodiment, the connection ring may be connected to the receptacle by other suitable means than the thread means. For example, it may be designed such that a pin is formed on the outer periphery of the cylindrical portion of the receptacle and an engagement groove is formed in the connection ring. This engagement groove has a first portion extending in the axial direction from the distal end of the connection ring, and a second portion extending in a circumferential direction from a rear end of this first portion. The engagement groove is generally of an L-shape. A mounting structure of the connection ring to the plug is the same as the preceding embodiment. In this embodiment, after the electrical connection between the contact elements of the plug and the contact elements of the receptacle is finished, the connection ring is moved in the axial direction with the pin inserted in the first portion of the engagement groove, and then the connection ring is turned to bring the pin to the second portion of the engagement groove to connect the connection ring and the receptacle together, and therefore to connect the receptacle and the plug together. In the midway of the movement of the connection ring in the axial direction with the pin positioned in the first portion of the engagement groove as mentioned above, the connection ring pushes the operating portion of the power source switch to turn on the power source switch.

FIG. **4** shows a modified embodiment of a plug **30'** and a receptacle **40'**. In FIG. **4**, like parts of the preceding embodiment are denoted by like reference numerals, respectively and description thereof is omitted. In this embodiment, the plug **30'** is simply inserted into the receptacle **40'**. A pressing flange (pressing member) **39** is formed on the outer periphery of the body **31** of the plug **30'**. During the process of insertion of the plug **30'** into the receptacle **40'**, the pressing flange **39** pushes the operating portion **17** of the power source switch **15** to turn on the power source switch **15**. What is important here is that the forming position of the pressing flange **39** on the body **31** is determined such that after the electrical connection between all contact elements **32** of the plug **30'** and all contact elements **42** of the receptacle **40** is finished, the power source switch **15** is turned on.

As shown in FIG. **4**, in the case where the connectors are connected to each other simply by insertion, it may be designed such that the diameter of the cylindrical portion of the first connector on the side of the CCD is made larger than the diameter of the cylindrical portion of the second connector on the side of the control unit, so that the contact elements of them are electrically connected to each other with the cylindrical portion of the second connector received in the cylindrical portion of the first connector. In that case, the distal end face of the cylindrical portion of the first connector may be served as a pressing portion for pushing the operating portion of the power source switch.

In FIG. **5**, a power source switch **15'** comprises a relay switch. The power source switch **15'** is connected to a

photo-coupler **50**. This photo-coupler **50** comprises a photodiode **51** and a photo-transistor **52**. The previously mentioned shaft **17***a* of the operating portion **17** can be moved in and out of between the photodiode **51** and the photo-transistor **52**. Normally, since the shaft **17***a* is biased by the coil spring, it is not located between the photodiode **51** and the photo-transistor **52**. In that case, the photo-transistor **52** is turned on upon receipt of light from the photodiode **51** and a driving circuit **60** is opened so that the coil **15***x* is not excited. When the shaft **17***a* is retreated pushed by the connection ring **35** or the pressing flange **39**, the shaft **17***a* enters between the photodiode **51** and the photo-transistor **52**. As a result, since the photo-transistor **52** is turned off, the driving circuit **60** is closed to excite the coil **15***x*. As a result, the power source switch **15'** is turned on.

It is acceptable that the micro-switch **15** of FIG. **3** is used as the power source switch and its contact element **15***a* is served directly as the operating portion. In that case, the power source switch **15** is mounted on the front surface of the front wall **11***a*, and the contact element **15***a* is pushed by the pressing member directly mounted on the second connector.

It is also acceptable that a pin is disposed, as the pressing member, on the connector of the endoscope, and this pin is allowed to extend through a through-hole formed in the front wall, so that the pin pushes a contact element of a power source switch disposed within the control unit.

In the above embodiments, the power source switch **14**, which can be turned on/off by means of operation of the user, may be omitted.

The present invention may be applied to a control system equipped with an image pick-up instrument having a CCD mounted on a distal end of a hard tube, instead of an endoscope. Also, the present invention may be applied to a system for controlling semiconductors other than CCD.

What is claimed is:

1. A semiconductor control system comprising:

(a) an instrument including a semiconductor;

(b) a cable extending from said instrument;

(c) a first connector mounted on one end of said cable and electrically connected to said semiconductor; and

(d) a control unit including:

(i) a housing;

(ii) a second connector disposed on a front wall of said housing, said first connector being removably connected to said second connector;

(iii) a power source circuit received in said housing;

(iv) a control circuit received in said housing and connected to said second connector; said control circuit being further connected to said power source circuit through a power source switch, said control circuit being capable of supplying a constant voltage to a power source terminal of said semiconductor when electrically connected to said power source circuit by turning on said power source switch, and thereafter supplying a control signal to a control terminal of said semiconductor, said control circuit being capable of stopping the output of control signal to said control terminal and then stopping the supply of voltage to said power source terminal when disconnected from said power source circuit by turning off said power source;

(v) characterized in that said housing is provided on a front wall thereof in the vicinity of said second connector with an operating portion for said power source switch, said operating portion being movable between a first position and a second position situated backwardly of said first position and in a direction generally perpendicular to said front wall of said housing, said power source switch being in an Off-state when said operating portion is in said first position, said power source switch being turned on in a midway of the movement of said operating portion from said first position to said second position, said first connector being provided with a pressing member, said pressing member, when said first connector is connected to said second connector, being moved toward said front wall of said housing, at that time, said pressing member pushing said operating portion so that said operating portion is moved from said first position to said second position; and

(e) said control unit including a second power source switch disposed between said power source circuit and said control unit and in a serial relation with the first-mentioned power source switch, a second operating portion for turning on/off said second power source switch being provided on said front wall of said housing but away from said second connector.

2. A semiconductor control system comprising:

(a) an instrument including a semiconductor;

(b) a cable extending from said instrument;

(c) a first connector mounted on one end of said cable and electrically connected to said semiconductor, said first connector having a cylindrical first body and a plurality of first contact elements disposed within said first body;

(d) a control unit including:

(i) a housing;

(ii) a second connector disposed on a front wall of said housing, said first connector being removably connected to said second connector, said second connector having a cylindrical second body and a plurality of second contact elements disposed within said second body;

(iii) a power source circuit received in said housing;

(iv) a control circuit received in said housing and connected to said second connector;

(v) a power source switch through which said control circuit is further connected to said power source circuit, an operating portion for said power source switch being mounted on said front wall of said housing in the vicinity of said second connector, said operating portion being maintained in a first position projected from said front wall of said housing under the effect of a spring disposed on a back side of said front wall of said housing, said operating portion being movable backwardly to a second position, said power source switch being in an off-state when said operating portion is in said first position, and said power source switch being turned on in a midway of the backward movement of said operating portion from said first position to said second position; and

(e) a connection ring mounted on an outer periphery of said first body of said first connector, said connection ring being turnable about said first body and movable in an axial direction of said first body within a predetermined range, said connection ring being threadedly engaged with said second body of said second connector after said first and second contact elements being connected to each other, said connection ring pressing said operating portion for said power source switch in the course of the engagement of said connection ring with said second body, thereby said operating portion

being moved backwardly to turn on said power source switch.

3. A semiconductor control system comprising:

(a) an instrument including a semiconductor;

(b) a cable extending from said instrument;

(c) a first connector mounted on one end of said cable and electrically connected to said semiconductor, said first connector having a cylindrical first body and a plurality of first contact elements disposed within said first body;

(d) a control unit including:

(i) a housing;

(ii) a second connector disposed on a front wall of said housing, said first connector being removably connected to said second connector, said second connector having a cylindrical second body and a plurality of second contact elements disposed within said second body;

(iii) a control circuit received in said housing;

(iv) a control circuit received in said housing and connected to said second connector;

(v) a power source switch through which said control circuit is further connected to said power source circuit, an operating portion for said power source switch being mounted on said front wall of said housing in the vicinity of said second connector, said operating portion being maintained in a first position projected from said front wall of said housing under the effect of a spring disposed on a back side of said front wall of said housing, said operating portion being movable backwardly to a second position, said power source switch being in an off-state when said operating portion is in said first position, and said power source switch being turned on in a midway of the backward movement of said operating portion from said first position to said second position; and

(e) a flange formed on an outer periphery of said first body of said first connector, said first and second contact elements being connected to each other by moving said first connector toward said second connector, said flange being moved together with said first connector to press and backwardly move said operating portion for said power source switch, said power source switch being turned on after said first and second contact elements are connected.

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